AN EVALUATION OF INSECT DAMAGE IN THE BEECH CREEK SEED ORCHARD - MURPHY, N.C., 1982

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INTRODUCTION

The production of superior seed from pine seed orchards is important in the southern United States, because trees grown from this seed exhibit increased volume growth, improved form and fiber characteristics, and reduced disease incidence. These superior trees are being heavily relied upon to produce increased quantities of higher quality forest products per unit area (FSM 2475.02). Federal seed orchards are just beginning to produce seed in quantity in some seed sources. This seed is being depended upon to regenerate National Forest lands with superior growing stock. Approximately 17,422 pounds of seed are needed annually from southern federal seed orchards for this purpose[2/]. In 1981, there were 71,654 acres of Forest Service land planted in Region 8 (USDA, FS, FS-379, 1982). Of this acreage, approximately 70 percent was planted with superior orchard seed.

During 1981, the Beech Creek, Francis Marion, and Ocala Orchards produced more than 5,200 pounds of superior seed, as compared to 2,778 pounds in 1980 (Barber, 1982 and Table 1 - personal communication, Jim McConnell[3/]). In 1979, all six federal orchards produced 5,857 pounds of superior seed, as compared to 13,834 pounds in 1981. Unfortunately, while production has improved for some species, such as loblolly, there are still extreme shortages in other species and sources, especially shortleaf and slash.

Insects are the chief agent causing losses in seed orchards (Overgaard, et al. 1974) and, if not controlled, will adversely affect the availability of superior pine seed, thereby reducing future timber production. Currently, there is no technique for predicting population trends of all seed orchard insects. Consequently, this evaluation is based on current seed, conelet, and cone damage at the Beech Creek Orchard, and does not attempt to predict future losses.

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[2/] Aycock, O. E. and R. E. Major. 1977. A study of R-8 seed processing facilities and needs. R-8 Report.

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Names of principal insect species, description of their biologies and behavior, and damaged caused (Ebel et al. 1975):

CONEWORMS, Dioryctria spp.

Coneworms--Dioryctria amatella (Hulst.), D. clarioralis (Walker), D. disclusa (Heinrich), D. ebeli (Matuura and Monroe), and D. merkeli (Matuura and Monroe). Biologies of coneworms are somewhat similar. Generally, these insects attack the flowers, buds, and shoots, as well as the conelets and cones. Damage consists of larval tunnels, with partially to totally excavated areas within infested structures (Ebel et al. 1975).

Coneworms, depending on the species, have one to seven generations a year. Young, first instar larvae overwinter and attack flowers and shoots the following spring. Late in the summer, cones are attacked. Some species, like D. amatella, infest fusiform rust Cronartium fusiforme Hedg. and Hunt galls and move to cones to complete their development.

PINE SEEDWORMS, Cydia spp.

Three species are prevalent in the South--the slash pine seedworm Cydia anaranjada Miller, the longleaf seedworm C. ingens Heinrich, and the eastern pine seedworm C. toreuta. Damage consists of larval feeding and development within maturing seeds and cones. Damage from these insects often prevents cones from opening, thereby affecting the extraction of seeds.

In general, one generation occurs each year in all species of seedworms. The adults emerge in spring, mate, and the female moth lays eggs on cones. The eggs hatch in three to six days, and young larvae bore into the cones. A larva enters a seed and completely consumes it and then bores into another seed. Each larva destroys one to seven seeds during its development and bores into the cone's axis in the fall, where it overwinters. The following spring, the larva pupates and develops to an adult moth, which emerges through a hole in one of the excavated seeds.

SEEDBUGS, Leptoglossus corculus (Say) and Tetyra bipunctata (H.-S.)

These are sucking insects which feed upon developing conelets and seeds. Adults are strong fliers, and nymphs are highly mobile, feeding on several conelets and cones during their life by puncturing them with their needle-like mouth parts. Early stages are gregarious and may kill conelets and cones. They also puncture developing seeds and destroy the endosperm, causing empty or partially developed seed.

Leptoglossus corculus overwinters as an adult. The eggs are laid in rows on pine needles. Several generations occur each year. Nymphs or early stages are present from April through October, and adults can be found in spring, summer, and fall. In the deep South, the largest populations occur in July and August.

The shieldback bug Tetyra bipunctata overwinters as an adult in the litter. This insect has one generation a year. Adult populations may become quite high in late summer and early fall.

NANTUCKET PINE TIP MOTH, Rhyacionia frustrana (Comstock)

Larvae of the Nantucket pine tip moth feed on tips of pines, destroying primordial tissue in stems during summer, thus preventing conelet production the following season. They also feed directly on young flowers and conelets in early spring. Severe infestations may greatly retard growth and cause forking of small pine trees. The hosts are shortleaf Pinus echinata Mill., loblolly P. taeda L., Virginia P. virginiana Mill., and sand pine P. clausa Chapm., Vasey. Slash pine P. elliottii Engelm. var. elliottii can be attacked; however, longleaf pine is resistant to this species of tip moth.

This moth has one to five generations, with the most generations occurring in the southern part of its range. Moths emerge in late winter or early spring and lay eggs on new shoots and needles of pines. Upon hatching, larvae feed on young shoots or young flowers. About the third instar, the larvae bore into shoots where they pupate and complete development.

PINE CONEBORERS, Eucosma cocana Kearfott and Eucosma tocullionana Heinrich

Damage is similar to that of Dioryctria spp., but the riddled white pine P. strobus L. and shortleaf pine cones tend to be packed with a mixture of chewings and frass, with no obvious tunnel system evident.

These insects usually have one generation a year. Moths emerge from pupae overwintering in the soil about April or May, and lay their eggs. Young larvae tend to feed in groups in immature cones and later disperse and become more solitary in infested cones. Although they disperse, the larvae tend to concentrate within major branch systems, so damaged cones are noticeably grouped within the tree crown. When mature (June-July), the larvae drop from the cones and pupate in the soil until the following spring.

WHITE PINE CONE BEETLE, Conophthorus coniperda (Schwarts)

The beetles attack the white pine cone at the cone base where it joins the stalk. A doughnut-shaped mass of resin-soaked, light brown frass is formed around the entrance hole. Attacked cones wither and die. One insect may attack several cones.

Adult females emerge in early spring and attack and lay eggs in several cones during a 30-day period. The female beetle constructs a gallery down the cone axis and lays eggs in from 1 to 24 niches in the gallery wall. The larvae feed on both cone and seed tissues. When cones are scarce, conelets are attacked, but no eggs are laid in them. One generation occurs yearly, and adults overwinter in infested cones.

OBJECTIVE

The objective of insect suppression on federal seed orchards is to achieve maximum production of superior seed with the least hazard to any non-target organisms.

GENERAL EVALUATION SURVEY TECHNIQUES

Cone Damage:

Coneworm, coneborer, and conebeetle. This damage is usually assessed one of two ways. The first method is to harvest 100 percent of the cone crop on selected clones and calculate the percent damaged cones. This method usually underestimates the amount of insect damage, as some of the damaged cones may be missing at harvest. The second technique is to employ the life table approach. This involves tagging a minimum of 10 percent of the flower crop and following them to maturity. This method is used to pinpoint the time and cause of mortality.

Seed Damage:

Seedbug and seedworm. In the past the Eastern Tree Seed Laboratory conducted two types of cone analysis to determine seed quality and insect damage (Bramlett et al. 1977).

Seed Orchard Seed Evaluation Testing (SOSET) provides a measure of seed production, viability of the extracted seed, and a radiographic analysis of the extracted seed. The radiographic analysis identifies insect problems, abnormal seed development, and the percentage of filled seed. This method is considered a continual monitoring technique.

Cone Analysis Service (CAS) consists of an indepth analysis of seed potential of cones, number of first and second year aborted ovules, percent sound seed, percent empty seed, percent seedbug and seedworm damage, and percent malformed seed.

Adult Male Coneworm Monitoring:

Pheromones for 4 of the 5 important coneworm species were field tested in 1980 and 1981. Beginning in 1982, these pheromones were used by all federal orchards to continually monitor the presence and abundance of these important insect pests. This is considered to be an integral part of each orchard's insect monitoring program.

METHODS

Source: N.C. white pine.

Treatments:

1. Furadan applied at 4 ounces per inch d.b.h. in 1981; 3 applications of Guthion and 1 application of Pydrin applied during 1982, May-September.

2. Check - untreated.

Design:

1. Six clones x two ramets per clone.

2. Ten percent of flower and cone crop.

Flower to Cone Survival:

Overall survival of the 1981 flower crop to harvest was very low, and the crop was not harvested in the fall (Table 1). In addition to low flower initiation (1981), nearly 75 percent of the flowers aborted or were missing in the treated area (Table 2). The primary cause for this is thought to be lack of pollination. Seedbugs might also be partially responsible.

Survival of the 1982 flower crop was 21 percent greater where Guthion/Pydrin was applied when compared to an area where no insecticides were used; i.e., 67.7 vs. 46.3 percent, respectively (Table 3). Again, as in 1981, a large proportion of the flower crop aborted (32.4%), even with the use of Guthion. This continues to suggest pollination problems.

Cone and Seed Production:

No crop was harvested during 1982.

Source: N.C. shortleaf.

Treatments:

1. Furadan, 10 percent applied at 4 ounces per inch d.b.h. in 1981; 3 applications of Guthion and 1 application of Pydrin applied during 1982.

2. Check - no treatment.

Design:

1. Six clones x two ramets per clone.

2. Ten percent of flower and cone crop.

Cone and Conelet Mortality:

More cones survived to harvest in the treated block than in the untreated block (72.9 vs. 64.5 percent, respectively). Most of the loss was due to missing abort/unknown; i.e., 25.7 and 33.1 percent in the treated and untreated areas, respectively. The greater part of this occurred during 1981 when only Furadan was applied (19.2 and 28.3 percent, respectively; Table 4).

Survival of the 1982 flower crop was much better, where nearly 92 percent survived in both the treated and untreated areas (Table 5).

Cone and Seed Production:

Shortleaf cone production (from all three sources) in 1982 was up compared to 1981; i.e., 308 vs. 180 bushels. Seed yield per bushel was .51 lbs./bu. for the Kentucky shortleaf, .65 lbs./bu. for the North Carolina shortleaf, and .69 lbs./bu. for the Virginia shortleaf. These yields continue to be below the hoped for production of 1 pound of seed per bushel. In 1981, the Kentucky shortleaf source yielded 1.07 lbs./bu. The highest shortleaf yield from any Forest Service orchard in 1982 was .88 lbs./bu. from the Mississippi shortleaf source on the Erambert (personal communication, Jim McConnell).

Table 1.--Cone and seed production from three federal seed orchards, 1980-1982.

Orchard	Source	Bushels			Pounds			Pounds per Bushel			Net Retrieval System; lbs. Collected
		1980	1981	1982	1980	1981	1982	1980	1981	1982	1982
Francis Marion	S.C. longleaf	44	283	215	10	150	77	.23	.53	.36	
	N.C. longleaf	28	223	309	26	204	163	.92	1.14	.66	
	Ga. loblolly	248	245		322	340		1.30	1.39		314
	S.C. piedmont loblolly	373	1820		336	2447		.90	1.35		911
	Francis Marion coastal loblolly	125	500	259	228	852	326	1.82	1.70	1.26	
	Ga. shortleaf	151	210	297	157	129	233	1.04	.61	.79	
	N.C. loblolly	4/	4/	93	4/	4/	90	4/	4/	.97	
	Orchard Total	969	3281	1173	1079	4171	4122	889			
Beech Creek	Ky. shortleaf	64	60	82	59	64	42	.92	1.07	.51	
	N.C. shortleaf	123	120	175	110	54	113	.89	.45	.65	
	Va. shortleaf	32	2/	51	26	2/	35	.81	2/	.69	
	White pine	2112	1958	5/	1499	834	5/	.69	.43	5/	
	Virginia pine	2/	1/	108	2/	1/	67	2/	1/	.63	
	Orchard Total	2331	2138	416	1694	952	257				
Ocala	Sand pine	4/	250	4/	5	138	3/	4/	.55	3/	
	Grand Total	3300	5669	1589	2773	5212	1146				1225

1/ Field observations indicated few sound seed per cone; therefore, the crop was not harvested.

2/ The crop was not harvested.

3/ Seed were not extracted as of March 1982.

4/ Unknown.

5/ No crop.

Table 2.--Flower[1/] to cone survival, N.C. white pine, Beech Creek Seed Orchard, 1982.

Treatment	Healthy	Missing/Aborted or Unknown	Conebeetle
	- - - - - - - - - - - percent - - - - - - - - - - -		
Furadan 1981/ Guthion/Pydrin 1982	14.2	74.8	11
Untreated	1.9	83.4	14.7

1/ 1981 flower crop.

Table 3.--Flower[1/] survival, N.C. white pine, Beech Creek Seed Orchard, 1982.

Treatment	Healthy	Missing/Aborted or Unknown	Conebeetle
	- - - - - - - - - - - percent - - - - - - - - - - -		
Guthion/Pydrin	67.6	32.4	-
Untreated	46.3	53.7	-

1/ 1982 flower crop through 9/82.

Table 4.--Flower[1/] to cone survival, N.C. shortleaf, Beech Creek Seed Orchard, 1982.

Treatment	Healthy	Missing/Aborted or Unknown	Coneworm/Coneborer
	- - - - - - - - - - - percent		- - - - - - - - - -
Furadan 1981/ Guthion/Pydrin 1982	72.9	25.7 2/	1.4
Untreated	64.5	33.1 3/	2.3

1/ 1981 flower crop to harvest, 9/82.

2/ As of 9/81 = 19.2%.

3/ As of 9/81 = 28.3%.

Table 5.--Flower[1/] survival, N.C. shortleaf, Beech Creek Seed Orchard, 1982.

Treatment	Healthy	Missing/Aborted or Unknown	Insect
	- - - - - - - - - - - percent		- - - - - - - - - -
Guthion/Pydrin 1982	91.8	8.0	0.2
Untreated	91.8	8.0	0.2

1/ 1982 flower crop to 10/82.

PHEROMONE RESULTS

Twenty pheromone traps were baited and placed in the tops of 20 shortleaf trees. The traps were monitored twice a week from April 1 through mid-October. Only 4 moths were caught on the Beech Creek Seed Orchard (Table 6). This indicates low coneworm activity compared to other Southern orchards (Appendix 1, Beech Creek = Orchard #34).

Table 6.--Dioryctria Pheromone Survey Listing of Total Moth Catch by Date.

Date	Species *D. merkeli* # moths trapped	 *D. amatella* # moths trapped
8/23	1	
9/7		1
9/16	2	

RECOMMENDATIONS

1. On producing sources, apply Guthion 2S or Pydrin by aircraft at 30-day intervals, beginning at flower closure and continuing through August. If this method of application is not possible, apply Guthion 2S or Pydrin via mist blower at the rate of 1 gallon of spray mix per tree.

2. The last spray treatment (Virginia and shortleaf pine), which normally occurs in September during cone harvest, should be with the newly registered insecticide, Pydrin. On white pine, apply Pydrin in early August just before harvest. Guthion should be used in mid-September to protect the conelets from seedbug attack.

3. To control white pine conebeetle, apply Furadan 10G at a rate of 4 oz./in. d.b.h. in December to producing clones.

4. On trees bearing control-pollinated flowers or cones, apply Furadan 10G in February or early March at the rate of 8 oz./in. d.b.h.

5. Establish 20 pheromone monitoring traps to determine relative population densities and activity periods of four coneworm species.

6. Establish and operate two light traps in a shortleaf pine source to detect the presence of the shortleaf pine coneborer.

7. If aerial application is used (either Pydrin or Guthion), add Nalcotrol at the rate of 2 to 3 ounces per 100 gallons of tank mix as a drift retardant.

8. Re-entry time for either Guthion or Pydrin is 48 hours.

9. Spray Mix Table:

Chemical	Via Mist Blower	Via Air
Guthion 2S	Mix 3 pints in 10 gallons of water. Apply 1 gallon per tree.	Mix 1-1/2 gallons (3 lbs. AI) with 8-1/2 gallons of water. Apply 10 gallons of spray mix per acre.
Pydrin	Mix 3.5 pints in 100 gallons of water. Apply 100 gallons of spray mix per acre.	Mix .31 gallons (.75 lbs. AI) with 9.69 gallons of water. Apply 10 gallons of spray mix per acre.

APPENDIX

PHEROMONE TRAP CATCH

APPENDIX I
1982 Dioryctria Pheromone Survey

Total Moths Trapped/Orchard

Rank by Total Trap	# D. clarioralis/ trapped / (Orch. ID#)	# D. disclusa/ trapped / (Orch. ID#)	# D. merkeli/ trapped / (Orch. ID#)	# D. amatella/ trapped / (Orch ID#
1	444/(107)	746/(17)	545/(112)	270/112)
2	239/(112)	435/(30)	380/(101)	253/(13)
3	213/(13)	432/(18)	283/(13)	181/(22)
4	151/(121)	340/(39)	230/(108)	172/(18)
5	130/(101)	323/(108)	213(16)	159/(101)
6	120/(102)	315/(19)	155/(102)	147/(117)
7	96/(110)	266/(14)	150/(15)	143/(17)
8	94/(117)	164/(6)	148/(104)	143/(20)
9	81/(119)	155/(13)	138/(103)	111/(15)
10	76/(116)	150/(107)	133/(122)	103/(4)
11	72/(22)	114/(28)	127/(123)	101/(105)
12	67/(7)	84/(115)	119/(18)	93/(104)
13	64/(115)	82/(103)	116/(26)	84/(122)
14	59/(15)	77/(104)	106/(19)	83/(9)
15	56/(118)	48/(112)	105/(111)	72/(110)
16	53/(105)	40/(16)	104/(10)	71/(106)
17	52/(17)	33/(119)	82/(36)	70/(27)
18	46/(111)	22/(15)	79/(38)	69/(7)
19	45/(113)	20/(22)	75/(117)	61/(107)
20	41/(20)	14/(10)	58/(106)	61/(119)
21	37/(12)	12/(105)	54/(31)	57/(14)
22	30/(38)	10/(10)	53/(110)	48/(12)
23	28/(32)	9/(32)	51/(105)	43/(1)
	27/(30)	9/(111)	44/(19)	43/(32)
	27/(108)	7/(36)	44/(109)	43/(37)
26	25/(10)	7/(113)	43/(115)	41/(25)
27	25/(36)	6/(1)	42/(5)	39/(115)
28	25/(123)	6/(11)	39/(17)	38/(108)
29	22/(5)	6/(26)	34/(4)	36/(111)
30	21/(19)	6/(110)	34/(37)	35/(16)
31	21/(35)	5/(23)	27/(23)	29/(113)
32	20/(18)	5/(116)	26/(20)	28/(5)
33	19/(6)	5/(120)	25/(6)	28/(116)
34	18/(14)	4/(102)	24/(116)	26/(102)
35	18/(37)	4/(114)	22/(25)	25/(3)
36	18/(109)	4/(124)	21/(35)	25/(121)
37	17/(16)	3/(4)	18/(9)	19/(103)
38	15/(1)	3/(38)	14/(121)	19/(109)
39	13/(33)	3/(106)	11/(1)	17/(28)
40	13/(106)	2/(12)	11/(113)	16/(120)
41	12/(27)	2/(101)	9/(107)	15/(19)
42	10/(4)	2/(123)	3/(34)	15/(118)
43	9/(104)	1/(9)	2/(40)	14/(39)
44	8/(11)	1/(25)	1/(2)	10/(11)
45	8/(28)	1/(33)	No Catch	10/(30)
46	5/(25)	1/(35)	"	10/(36)
47	5/(124)	1/(109)	"	10/(38)
	4/(3)	1/(118)	"	6/(24)
	4/(8)	1/(121)	"	8/(124)
	4/(9)	No Catch	"	6/(26)

GENERAL DISCUSSION

Suppression generally yielded positive increases in sound flowers and cones, where insecticides were used. This was true on the Beech Creek, where shortleaf production in 1982 rose to 308 bushels, up from 180 bushels in 1981. In addition, the orchard harvested 108 bushels of Virginia pine in 1982, where none were harvested in 1980 or 1981. Because of low white pine flower initiation and survival during 1981, there was no harvest in 1982. The white pine trees were treated in 1982 to protect the flower crop that will be harvested as cones in 1983.

Aerial application of insecticides is now recommended for the Beech Creek. The technology has been developed in the past two years and has proven effective. Most private industry orchards are already using aerial application. This method of application has several advantages:

1. Reduction in total insecticide usage (environmental impact).

2. Better timing of application.

3. Less off-target drift of toxic insecticides.

4. Less exposure to workers.

5. Cost reduction (see 1 above); often a sizable reduction in insecticide expenditures.

The use of pheromones is also new to federal orchards. This technology was only developed within the last three years. This past year, 64 orchards across the South used pheromones to determine the relative coneworm populations on their orchards. In future years, managers may be using pheromone traps to time pesticide applications and to predict pest problems. Compared to other orchards, the Beech Creek caught relatively few moths (Appendix 1).

The insecticide, Pydrin, was recently registered for use on seed orchards. This insecticide offers the advantage of being much safer to use than Guthion. The label was recently changed to allow the application of up to 6.2 pounds active ingredient per year. Under present spray schedules, 5 or 6 applications are needed for season-long protection.

The recommendations contained herein call for the use of one application of Pydrin at the time the field workers will be collecting cones. This should increase worker safety at cone collection time, as well as provide an extra margin of protection against seedbugs, which are common at this time of year. Pydrin is thought to have longer residual activity in the field than Guthion, thus yielding the extra protection.

Appraisal of Current Significance:

Coneworm activity on the Beech Creek was thought to be low during 1982, as determined by low pheromone trap catches and apparent insect damage. In comparison, coneborer activity was on the increase in certain shortleaf sources.

Seedbugs continue to cause considerable damage to some sources and less to others. While no data exist to document this for 1982, seedbugs were present and observed in the field.

Conebeetle damage was observed on white pine during 1982. Because of a previous decision not to harvest the small, 1982 crop, no control measures were taken against the conebeetle. The conebeetle virtually destroyed what remained of the small, 1982 cone crop.

Appraisal of Potential Significance:

The reproduction potential of each insect species involved is not known. Any one species is capable of causing serious losses in any given year, and losses exceeding 90 percent of the possible seed crop are not unusual.

Course of the Outbreak, If Unchecked:

The course of the outbreak, if left unchecked, is unknown. Populations of the different species of insects affecting pine production fluctuate considerably from year to year according to climatic conditions and parasite-predator populations. However, it is known that serious losses will continue unless checked.

Course of the Outbreak, If Checked:

Although excessive seed and cone losses will be prevented by treatments during the year of application, continued treatments will be needed from year to year due to rapid buildup of insect populations in the orchard and reinfestation of populations from wild pine stands.

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